

Multiple Universes (7 types)

(1) Quilted Multiverse

- **If** the universe is infinite* (given in 2), **then** finite scenarios mean patches must repeat.
- --* uncertainty principle, loop quantum gravity, string theory, Tegmark's computable,
- --introduces definition of universe

(2) Inflationary Multiverse

- Inflation explains uniformity of microwave b.g. (quantum field negative pressure → negative gravity pulse). Started < proton and created energy from expanding to size of pea. Then inflation to current in a blink.
- Eternal inflation (cannot end) → bubble universes from random quantum fluctuations = "cosmic Swiss cheese." Predicted exactly the pattern of b.g. temperature ripples (fig).
- Different physical properties in each. Properties of matter and forces. E.G. from Higgs field values – diff properties of fundamental particles
 - Electrical force / gravity – smaller = short-lived miniature universe, no time for evolution
 - Nuclear force, how the elements are created – slightly different, no life
 - Mass density of the universe – too low, no galaxies/stars, too high, collapsed long ago.
 - Cosmological constant, dark energy (neg gravity) – if bigger, no formation of galaxies and stars.
 - Ratio → cosmic structure (ripples) – smaller, inert; much larger, dominated by giant black holes.
- **String-theory*** "landscape" matches 1:1 inflationary bubbles – 10^{500} possibilities.
- --* Incompatibility of gravity/forces relativity/quantum, model at Plank length and Plank mass.
- Strong anthropic principle (Stenger definition) → "*Fallacy of Fine Tuning*" (1) *That it couldn't be any other way (range is possible), and problems defining.* (2) *When other parameters are varied at the same time, the range of viable universes greatly increases. Simulation generated 10,000 universes with random values: 1/3 support life like ours. (Weinberg, Tegmark, Rees also).*
- BIG TWIST: Relativity → bubbles from the *inside* are *infinite*! [Tegmark disagrees]

- So... Quilted is nested within Inflationary; parallel within parallel; plus... a *third* nested realm of parallel—

(3) Quantum Multiverse

- Hugh Everett – censored genius, 1956, Wheeler/Bohr
- Identical experiments with particles get different results. But the probabilities of the results are extremely precise and predictable. The probability distributions look like interfering waves, rather than particles.
- Wave function is a mathematical shape that shows a range of states existing simultaneously, [It's a 10-dimensional config space using imaginary numbers, where a point refers to the positions of all particles being measured] ,and the mix changes predictably with great precision, but always a range of values simultaneously. Bohr said: collapses to point, and shape = probability distrib. (figure)
- The problem (1) Shrodinger's math doesn't allow becoming a spike. (2) meaning of measurement or observation is unclear.
- HERE'S WHAT REALLY HAPPENS: EXAMPLE Wave function shows particle at two places simultaneously. Bohr says measurement collapses it to one of them. Everett says no, the world splits into two: one version of the observer measuring the particle to be at point A, and another version of the observer measuring it at point B. This is really *exactly what* Shroedinger's equation is saying. We're just taking it literally, makes a simpler model.
- This is NOT a SPLIT into two worlds. This is two worlds coexisting, differing only in that one particle. These are just two of a vast multiverse of millions of closely related Nows. Plus: PROBABILITY = COPIES. (fig)
- **Compare to Deutsch: (A)** just looking at ordinary light patterns as photons shows us multiple worlds, even without quantum mechanics or even waves! Tangible & shadow photons (1:1trillion)
- **(B) Other times as other universes:** "the sequence of moments does not exist within the framework of time, it *is* the framework of time... A particular moment cannot become the present, or cease to be the present, for these would be changes. Therefore the present cannot, objectively, be a single moment." → "There is no fundamental distinction between snapshots of other times and snapshots of other universes. Other times are just special cases of other universes." "No single snapshot *itself* determines another snapshot and so it is not a cause."

ALTERNATIVE: Quantum Multiverse all in one universe

Third interpretation: reversible time at quantum level. E.g. exchange of photons inside atom – all possible directions in space and time. Not ruled out by anything in physics. For example, a positron is treated as an electron going backwards in time. He says currently the abstract mathematics is considered more real than the particles described. But reversible time makes particles the real things, simpler, solves all supposed paradoxes. “The multiple paths that quantum particles simultaneously take can be fitted into a single world when those particles are allowed to go back and then forward again along a new path.”

(4) Mathematical or Ultimate Multiverse

Math does not just describe reality, reality is literally a mathematical structure, and that is all. Read journal yellow. --if mathematics is reality, it will be experienced as physical, couldn't be otherwise. [consciousness is the way information feels when your self model interacts with your world model.]

“Mathematical structures are eternal and unchanging: they don't exist in space and time— rather, space and time exist in (some of) them. If cosmic history were a movie, then the mathematical structure would be the entire DVD. The Mathematical Universe Hypothesis (MUH) implies that the flow of time is an illusion, as is change. SHOW BRAIDLIKE ILLUSTRATION?

“The theory that our external physical reality is perfectly described by a mathematical structure while still not being one is 100% unscientific in the sense of making no observable predictions whatsoever.”

Family tree of mathematical structures – fig 12.1

Mathematical Universe Hypothesis means all mathematical structures are real and physical, each constituting a separate independent universe. Or is it only computable structures? Read journal yellow 2.

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(5&6) String-Theory Multiverses

- 3-Brane multiverse – a 4th level!
- Cyclic colliding branes create a 5th level or an alternative kind of multiverse Cyclic collisions – gravitational ricochet, obliterate all structure. The big splat. Cycle about trillion years.
- Predicts an additional pattern in the background microwave radiation caused by gravity waves – seeking it, show if we originated from inflationary bubble or a brane collision.

(7) Timeless Multiverse or Platonia

(7) Platonica (15 min.) – “what is time?”

Assume what's real is configurations (a 3-D snapshot at one instant), no space-time, no container, only measure distances between things. This is all you know, a heap of snapshots. Each is called a “Now”. You can order the Nows into a sequence purely by their intrinsic relatedness (without concept of time). A direction is inferred by information in one Now *implying* another Now *seemingly* “preceding” it in the sequence.

Simplified example is Triangle Land. **Figures** – 3D phase space → infinite dimension configuration space Platonica – both mapping out what is possible. == There is no “in the beginning.” The “creator” simply creates each Now because of its “necessity”, which turns out to be logic itself. The Nows collectively help each other into existence. Another way to say it: “the structure of quantum cosmology may well cause the wave function of the whole universe to “seek out” time capsules.”

Platonica “weeds out all those Nows that don't resonate with their peers.” Thus we don't split into Many Worlds, the Nows are just “all there” together. → reduces creator “god” to one bit of information, one binary choice.

TIME is simply a mathematical “best match” between Nows that determines which is the closest (“next”). Time is not a substance, thing, or dimension, only an implied relationship between configurations that is pure logic or math. Nothing moves.

Barbour derived both Newtonian and relativistic physics from simple assumptions = convincing. [1. Relativity is not about time, it's about clocks. 2. Simultaneity is not a property of the world, but of how we describe it. 3. The multiplicity of relativistic reference frames makes no difference to Platonica, only to observers.]

Time is only “evidence” in the present moment, **therefore a “real” past is irrelevant and literally meaningless**. You are really born anew every instant. You are not really connected with your past. It's not you, it's either an illusion or another person. You have no responsibility for what that person did.